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Implications of Auction Theory for New Issues Markets

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Further information about the auction software described herein and its availability for applications in the financial services sector is available from the author. Further materials on auction theory and practice are available on the author's website, www.ausubel.com, and on www.efficientauctions.com and www.market-design.com.

1 Introduction

Imagine attempting to explain to a visitor, from another era or another planet, the economic rationale behind various institutions in the American economy at the start of the 21st century. Few practices seem more difficult to justify to the outsider than the current procedure for the issuance of equity securities. The share price in initial public offerings (IPO's) often bears little connection to the equating of supply and demand, so that IPO's are sometimes massively oversubscribed and the share price increases by as much as a factor of five from the offering price to the close of the first day of trading. Shares in these oversubscribed offerings are rationed, not according to willingness to pay, but to favored clients of the underwriting investment banks. Often there is at least the appearance that clients receive their allotments in exchange for returning value to the investment banks in other transactions; and recently there have been allegations that some allotments have been made in exchange for agreements to buy additional shares on the open market after the IPO. While the associated returns foregone by the sellers (i.e., the companies going public) would be easier to justify if the explicit fees for the service were commensurately discounted, the explicit fees charged for IPO's actually seem quite high, generally a 7% commission on proceeds from the new shares.[1]

The main objective of this paper is not to hammer away at the inefficiencies present in the current system of new equity issuance; nor to attempt to explain what prevents the current system from being swept aside. Rather, this paper seeks to draw from new developments in market design—both theoretical results and new practices in other sectors—and to highlight alternative procedures that may be best suited to supplement or replace the current flawed system.

2 Comments on Current Practice for New Equity Issuance

The years 2000 and 2001 have seen Securities and Exchange Commission (SEC) investigations into two alleged abuses in the current practice for new equity issuance, a $100 million tentative settlement of charges by Credit Suisse First Boston, and a plethora of private lawsuits filed. In May 2001, *The Economist* provided an early, well written, and somewhat skeptical synopsis:

> Were investment banks crooked when they made billions of dollars from the Internet bubble?
>
> It enjoyed the dotcom party as much as anyone. But now that the whole thing has ended messily, Wall Street has become everybody's favourite scapegoat. Its analysts are accused of abandoning objectivity to tout shares that their investment banks underwrote. Underwriters are said to have set the share price too low in initial public offerings (IPOs), so as to ensure a huge jump in the price when trading began. That jump in turn enabled investment banks to reward favoured clients who were allocated shares in the IPO, which clients could instantly sell at a fat profit. To compound the rascality, the banks shared in those profits by demanding return favours from the clients.[2]

[1] The underwriting commission was exactly 7% for more than 90% of U.S. IPO's raising $20-80 million in recent years (Chen and Ritter, 2000).

[2] "Wall Street under scrutiny: A penny in whose pocket?" *The Economist*, May 24, 2001.

No matter how farfetched or corrupt this scenario seemed, by early 2002 substantial evidence had accumulated supporting some of these claims. Credit Suisse First Boston had reached final agreement on a $100 million settlement of government charges. According to published accounts, "The regulators singled out First Boston, accusing it of demanding that customers pay back some of the profit they made from trading new stocks in the form of inflated commissions on other stock trades. Investigators gathered evidence, including e-mail messages, that indicated that the firm's sale representatives had told some customers to pay the firm at least $1 in commissions for every $3 of new-stock trading profits."[3] Furthermore, "Plaintiffs' lawyers have filed more than 1,000 lawsuits against First Boston and about four dozen other securities firms, asserting that they manipulated the prices of new stocks in various ways. Those suits contend that sales representatives at First Boston gave relatively big allocations of new stocks to professional investors in exchange for a share of the profits those buyers made by reselling the stocks. They also contend that other investment banks, including Goldman, Sachs and Morgan Stanley Dean Witter, solicited promises from investors that they would buy more shares of a new stock at higher prices after it started trading. Such arrangements, expressly prohibited by securities laws, could have driven new stocks to artificially high prices. Spokeswomen for Goldman, Sachs and Morgan Stanley declined to comment. Federal regulators are continuing to investigate the second practice, known on Wall Street as 'laddering' a stock, and they may still bring charges against one or more investment banks."[4]

There has been some speculation that the SEC and the National Association of Securities Dealers might issue rules forbidding kickbacks or inflated commissions in IPO allocations. But, according to published accounts, regulators correctly recognize that an incremental change in rules may do little to prevent recurrent abuses. "It's very difficult to draw up rules to regulate allocation of shares that are underpriced," one official is quoted as saying.[5]

Rather, the perspective of the current paper is that a more radical overhaul of current practice is necessary: a change to a modern auction system that provides an open transparent mechanism for price discovery. This is the clearest way that the current underpricing—and the accompanying incentives for abuse—can be eliminated.

3 Auction Theory Preliminaries

This section will provide some background information on auction formats that might be contemplated for new issues markets and some associated results in the literature.

3.1 Sealed-Bid, Multi-Unit Auction Formats

Sealed-bid, multi-unit auction formats are best known in the financial sector for their longtime and widespread use in the sale of central government securities. For example, ten years ago, the

[3] "First Boston Seen Settling Kickback Case," *The New York Times*, December 12, 2001, p. C1.

[4] "First Boston Seen Settling Kickback Case," *The New York Times*, December 12, 2001, p. C1.

[5] "US may drop IPO rule changes: Doubts are increasing as to whether changing share allocation practice would end abuses," *The Financial Times*, December 12, 2001, p. 23.

Joint Report on the Government Securities Market surveyed OECD countries and found that the U.S., Australia, Canada, Denmark, France, Germany, Italy, Japan, New Zealand and the United Kingdom then used sealed-bid auctions for selling at least some of their government securities.[6] For many years, sealed-bid auctions have also been used rather extensively for share repurchases by publicly traded companies[7] and, in relatively rare instances, for IPO's.[8]

Pay-As-Bid Auctions.[9] Bidders submit sealed bids that effectively comprise demand curves. The auctioneer aggregates the bids and determines the clearing price at which demand equals supply. Each bidder wins the quantity demanded at the clearing price, and pays the amount that he bid for each unit won.

Uniform-Price Auctions.[10] Bidders submit sealed bids that effectively comprise demand curves. The auctioneer aggregates the bids and determines the clearing price at which demand equals supply. Each bidder wins the quantity demanded at the clearing price, and pays the clearing price for each unit won.

3.2 Ascending-Bid, Multi-Unit Auction Formats

Ascending-bid, multi-unit auction formats have become dominant in recent years for government sales of telecommunications spectrum. As described in Section 4 below, they are also coming into significant use in the energy and environmental sectors.

Simultaneous Ascending Auctions.[11] The items are auctioned simultaneously in multiple rounds of bidding. In each round, bidders may submit new bids. A bid is a pair comprising an item and an associated price (higher than the standing high bid). Bids can continue to be submitted for any item until the auction ends for all items; the auction ends only when a round elapses with no new bids submitted for any of the items.

Ascending Clock Auctions.[12] In each round, the auctioneer announces a price (or price vector) for the items being auctioned, and bidders respond with bids. A bid comprises a quantity of items demanded at the announced price. If the aggregate demand exceeds the supply, the auctioneer raises the price and the process repeats. The auction ends at the first price at which aggregate demand is less than or equal to supply.

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[6] U.S. Department of the Treasury, U.S. Securities and Exchange Commission, and Board of Governors of the Federal Reserve System (1992), *Joint Report on the Government Securities Market*, pp. B–25 - B–26.

[7] *See* Bagwell, Laurie S. (1992) and Gay, Kale and Noe (1991).

[8] *See* Kandel, Sarig, and Wohl (1999) and Sherman (2001).

[9] Pay-as-bid auctions are often referred to as "pay-your-bid auctions," or less descriptively, as "discriminatory auctions" or "multiple-price auctions." They generalize the sealed-bid, first-price auction for single items.

[10] Uniform-price auctions are often referred to, less descriptively, in the financial press as "Dutch auctions," or variously as "nondiscriminatory auctions," "competitive auctions," or "single-price auctions." It is sometimes asserted (incorrectly) that they generalize the sealed-bid, second-price auction for single items. However, the correct multi-unit generalization of the second-price auction is due to Vickrey (1961).

[11] *See* Cramton (1995) and Milgrom (2000).

[12] See Ausubel (1997, 1999, 2000a, b).

Variations on the simultaneous ascending auction have been used during 1994-2001 for spectrum auctions on six continents generating more than $100 billion in revenues. Among the best-known examples of these auctions were the U.S. PCS auctions of 1994-96 and 2001, the UK 3G auction in 2000, and the German 3G auction in 2000. When large numbers of identical items are to be auctioned—as is the case in the issuance of equity or debt securities—it is often advantageous to instead formulate the procedure as an ascending clock auction. Since the auctioneer, rather than bidders, names the prices in a clock auction, the auctioneer has greater control over the speed of the clock auction and can assure that it runs at a deliberate pace. The EDF Generation Capacity Auction and the UK Emissions Trading Scheme Auction, described in the next section, are two examples of high-stakes ascending clock auctions.

3.3 Standard Results of Auction Theory

Auction formats are generally evaluated according to two criteria: efficiency, the extent to which the auction assigns items to the bidders who value them the most; and revenue maximization, the extent to which the auction maximizes the seller's expected revenues. Most of the early results of auction theory concern sales of single items. If bidders are symmetric and have pure private values, the sealed-bid first-price, the sealed-bid second-price, and the ascending (English) auction all achieve equal efficiency and seller revenues. However, to the extent that bidders' valuations are affiliated (approximately meaning positively correlated) with one another, ascending auctions outperform sealed-bid auctions with respect to revenues (Milgrom and Weber, 1982). The intuition often provided for this result is that sealed-bid auctions are particularly susceptible to the "Winner's Curse": a bidder is more likely to win an auction when opposing bidders possess unfavorable information and so, in this sense, winning may be bad news. However, since an ascending auction provides bidders with continuous feedback about the opposing bidders' valuations, providing opportunities to draw inferences and to respond accordingly, it ameliorates the Winner's Curse and leads on average to more aggressive bidding, to the seller's ultimate benefit.[13]

More recent work in the auction literature has examined multi-unit auctions. Much of the empirical emphasis has been on the comparison between the pay-as-bid auction and uniform-price auction. Indeed, the U.S. Treasury conducted an "experiment" from 1992 to 1998 of using the uniform-price auction for selling 2-year and 5-year notes and using the pay-as-bid auction for selling other Treasury durations (Malvey and Archibald, 1998), and then switched entirely to the uniform-price auction in November 1998. However, the theoretical literature makes clear that, except in very special circumstances, the revenue rankings of the pay-as-bid and uniform-price auctions are inherently ambiguous, and both formats inevitably yield inefficient outcomes (Ausubel and Cramton, 1996). Moreover, any focus on the pay-as-bid and uniform-price formats ignores other auction approaches that are likely to outperform both.

In particular, ascending-bid multi-unit auction formats offer several decisive advantages over sealed-bid multi-unit auction formats. First, the insight from single-item auctions that the continuous feedback about other bidders' valuations would ameliorate the Winner's Curse and lead to more aggressive bidding should be expected to carry over to many multi-unit

[13] *See* McAfee and McMillan (1987) for an excellent survey of the early results of auction theory.

environments. This intuition led the *Joint Report on the Government Securities Market* to conclude: "Irrespective of whether the single-price, sealed-bid auction would prove superior to the current practice, the Agencies believe that there is an auction technique that may be superior to both types of sealed-bid auction techniques discussed above. This is an ascending-price, open auction system, which will be feasible for the first time once the auctions are automated." [14] Second, ascending-clock auctions, better than sealed-bid auctions, allow bidders to maintain the privacy of their valuations for the items being sold. Bidders never need to submit any indications of interest at any prices above the auction's clearing price. Third, an efficient ascending-bid auction format, improving upon the basic clock auction design, has been developed in recent years. This paper will continue by, first, in Section 4 describing two practical implementations of clock auctions, and then in Section 5 explaining the efficient ascending-bid auction.

4 Case Studies: High-Stakes Auctions in Other Sectors of the Economy

This section of the paper does not in any way attempt to provide a comprehensive survey of modern auction techniques as applied to other sectors of the economy. Rather, it focuses on two specific high-stakes, real-world auctions utilizing designs that are also well suited for financial services applications, including the issuance of securities. They are both projects that the author has helped to run during the time since he agreed to write this paper.

4.1 The Electricité de France (EDF) Generation Capacity Auctions

Electricité de France (EDF), the dominant power producer in France and the world's largest electricity group, committed in an agreement with the European Commission (in connection with EDF's acquisition of a substantial interest in German utility Energie Baden-Württemberg AG) to begin the divestment of 6,000 megawatts of generation capacity in 2001. The 6,000 megawatts to be sold represented approximately 10% of France's electricity supply. This divestment would be accomplished not by selling the physical power plants, but by selling "virtual power plants" (VPP's), option contracts replicating the outputs of the power plants. Two basic types of virtual power plants would be sold: (a) base-load VPP's, whose strike prices would equal the variable cost of a nuclear power plant (and so the options would be exercised essentially around the clock, 365 days per year); and (b) peak-load VPP's, whose strike prices would equal the variable cost of a peak load plant (and so the options would be exercised only at peak times). Base-load and peak-load VPP's in a variety of durations would be offered. In addition, a third type of product, "Power Purchase Agreements" (PPA's), would be sold. PPA's represent a block of power based on the output from co-generation plants under power purchase contracts.

The French generation capacity is being sold by way of a dynamic, ascending-clock auction. To date, EDF has conducted three capacity auctions, in September 2001, December 2001 and March 2002, advised by PricewaterhouseCoopers and Market Design Inc. The following description will largely focus on the first auction, in which VPP's representing some 300 million Euros worth of electricity were sold.[15]

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[14] U.S. Department of the Treasury, U.S. Securities and Exchange Commission, and Board of Governors of the Federal Reserve System (1992), *Joint Report on the Government Securities Market*, pp. 14-15.

[15] The author managed Market Design Inc.'s participation in the project, which included designing the auction, developing the auction software, and advising EDF in the conduct of the auction. More detailed information about the EDF Generation Capacity Auctions is available at the following URL's: http://www.efficientauctions.com/electricity.htm and http://www.edf.fr/htm/en/enchere/enchere/.

In the first auction, an initial tranche of 1,190 megawatts (MW) of electricity was offered. This generation capacity was sold in fifteen products, ordered as five product "groups":

- Product Group A: VPP Base-Load Product
  - Six durations, all beginning 1/1/2002
  - Supply = 800 MW
- Product Group B: VPP Peak-Load Product
  - Six durations, all beginning 1/1/2002
  - Supply = 200 MW
- Product Group C: VPP Base-Load Product
  - One duration: 11/1/2001 – 12/31/2001
  - Supply = 800 MW, limited by Group A
- Product Group D: VPP Peak-Load Product
  - One duration: 11/1/2001 – 12/31/2001
  - Supply = 200 MW, limited by Group B
- Product Group E: PPA Product
  - One duration: 1/1/2002 – 12/31/2002
  - Supply = 190 MW

In broad perspective, the auction is conducted as a practical implementation of the fictitious "Walrasian auctioneer" of microeconomics theory. The auctioneer (seller) begins the auction by announcing a price vector for each of the 15 products. The participating bidders (buyers) each respond with a quantity demanded of each of the 15 products (limited by a constraint that no single bidder can demand more than 45% of the available supply). The auctioneer announces the aggregate demand for each product, compares the aggregate demand for each product group with the available supply, and adjusts the price vector accordingly. The process is repeated until all of the product groups clear.

The EDF Generation Capacity Auctions are implemented on proprietary, commercial-grade software designed for clock auctions. The auction software operates on a web server located in Europe, with a backup server located in the United States. Bidders submit bids in the auction and follow the auction's progress using standard web browsers (Internet Explorer or Netscape Navigator). The auction software utilizes a variety of security features, including: 128-bit SSL (the same encryption standard used by financial institutions on the Internet); a digital certificate for establishing authentification; a web server protected by a firewall; and login ID's and passwords distributed to bidders by non-electronic means. In the event that an individual bidder suffers failure of his own computer system or Internet connection, the bidder contacts the auction administrator and submits his bid by fax. The software then permits the auction administrator to enter a bid on behalf of a bidder. All transactions on the auction system are recorded in an audit file. The audit file notes the time and amount of all bid submissions. It also records such other events as a bid placed by the auction administrator on behalf of a bidder.

The three EDF Generation Capacity Auctions to date appear to have been entirely successful. They have attracted the participation of some 45 energy traders and suppliers, with more than 20 bidders emerging as successful purchasers. The first two auctions concluded in ten rounds each, and the third auction concluded in nine rounds. Due to the fact that it was the first auction,